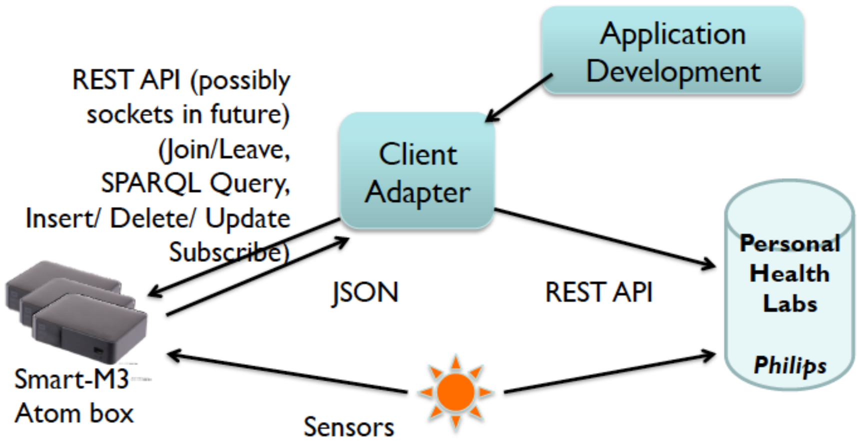
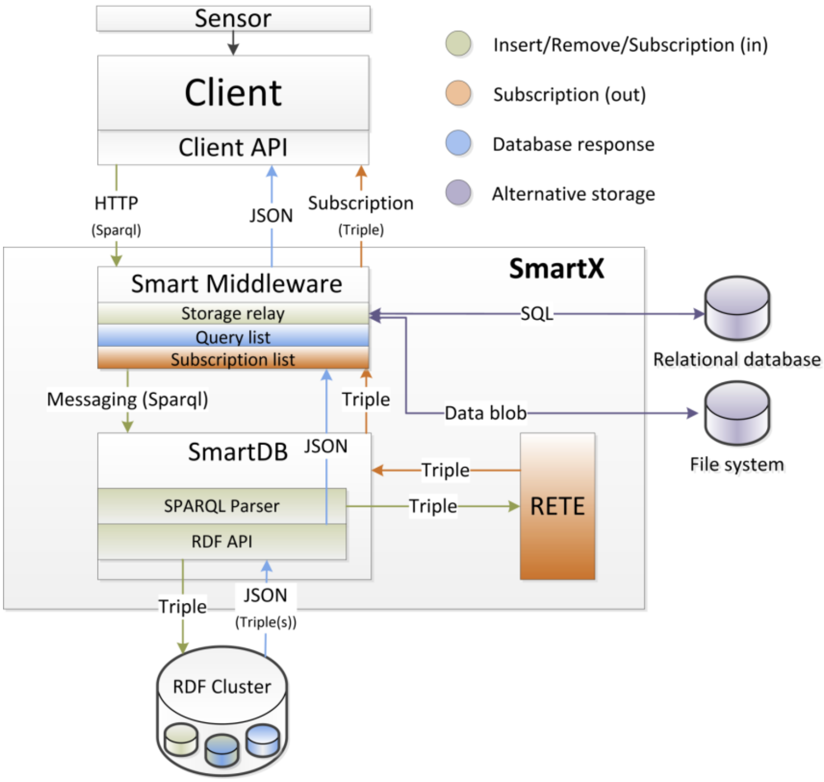
1. **Smart-M3 semantic storage box**
2. **Kinect-based application on remote rehabilitation monitoring/activity recognition.**

1. Smart-M3 semantic storage box

We deployed a semantic RDF store for ontology-based knowledge representation and publish/subscribe-based rules. The store is running on an (low power) Atom board. At the moment SSAP (Smart Space Application Protocol) and SPARQL protocols are available, but we will provide in the next months a RESTful interface.

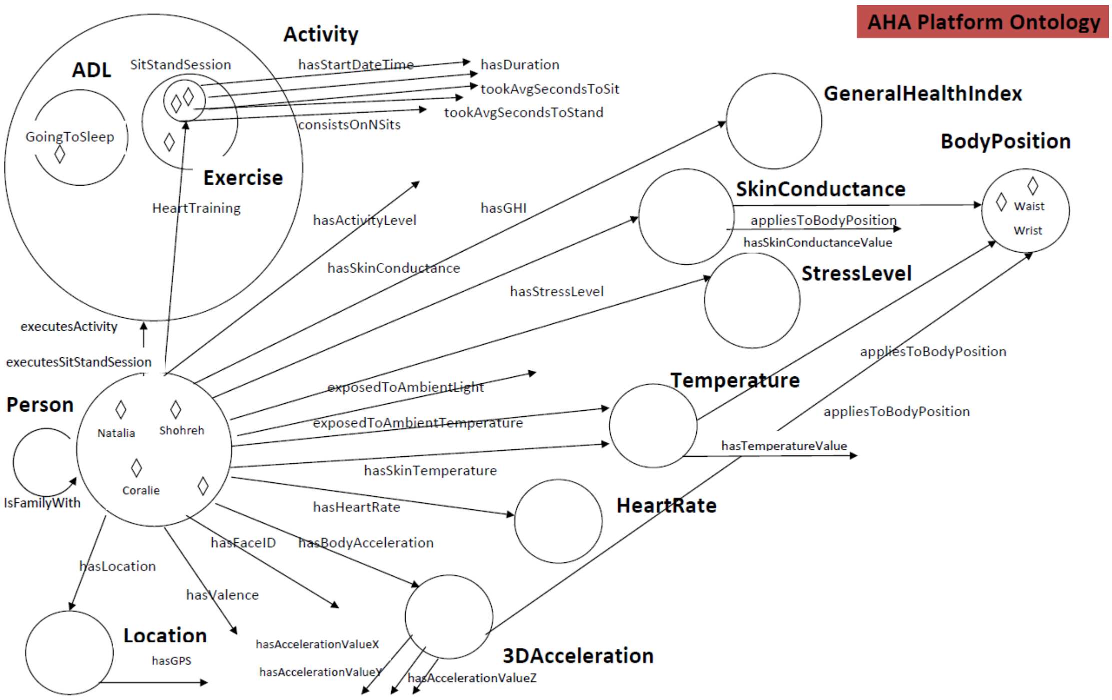


Smart-M3 platform is available for download:
http://sourceforge.net/projects/smart-m3/
Overall current M3 internal architecture:

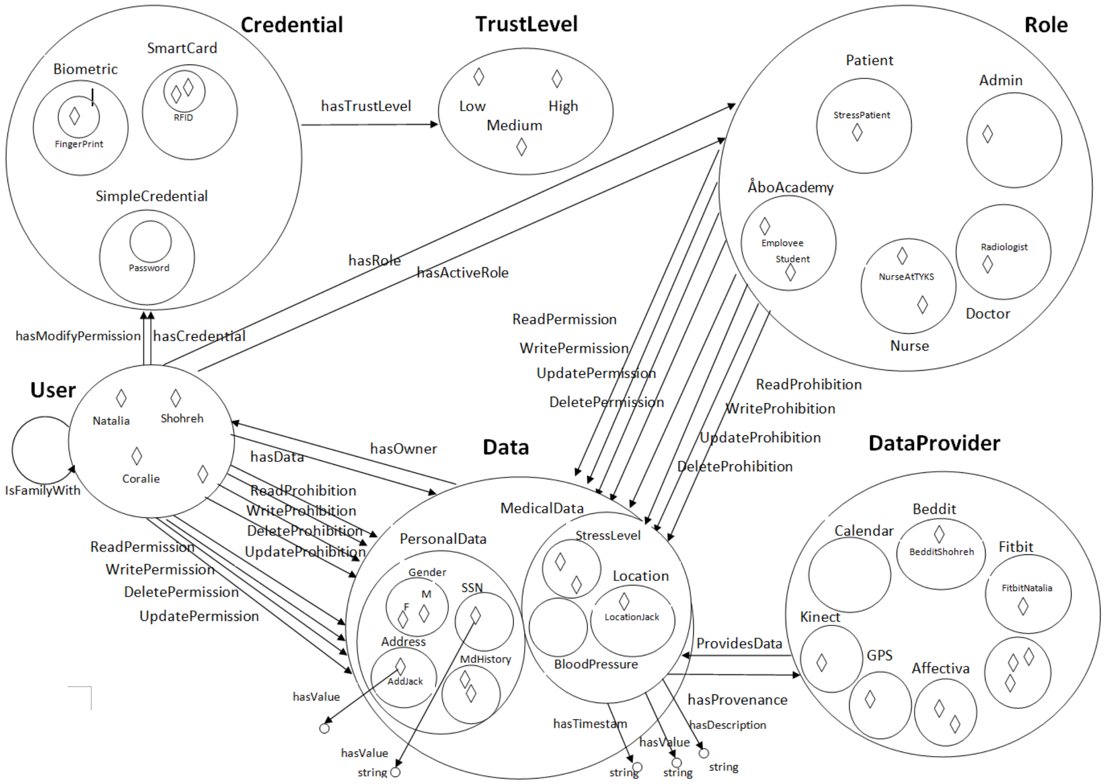


AHA Platform Ontology

- AHA sensor data interoperability (to be completed with Arjan Claassen for keeping consistency and interoperability among relational - Personal Health Labs API- and semantic –Smart M3- platforms).



- Security and Privacy ontology –can be completed together with Fraunhofer and INRIA Grenoble within AmiQoLT innovation Factory and UI toolbox.



Current state of the REST API: http://docs.frankwickstrom.apiary.io/

2. **Kinect-based application on remote rehabilitation monitoring/activity recognition.**

Application Use Case: Rehab@Home

The application proposal encompasses two aspects of health care and well-being: activity **monitoring** and **activity feedback**, integrated into everyday lives of senior citizens. The project does not only focus on the senior citizen of today, but also on the to-be senior citizen´s expectations on applications designed to enhance their future everyday environments, thus enabling design solutions that will be sustainable both from a social and an economical/business point-of-view.

The target groups

The primary target group consists of senior citizens living independently, through their own choice, who wish to maintain an independent lifestyle. They are facing an increasing need of care and medication and diminishing capabilities to maintain an active social life, partly due to living in isolated/mobility-challenged areas such as the Turku archipelago, as is the case in the pilot project. Members of this target group cannot in general be expected to be used to technological aid solutions, and may even be inclined to shy away from new products and services due to their unfamiliarity.

Background

The area around Turku is an archipelago of islands, where many islands are populated with few people. The particular challenge in this case is to provide health related services, in particular during the autumn and spring, when the weather conditions make it difficult to reach the islands (e.g. when the ice is not strong enough to carry cars, but strong enough to preclude reaching the islands by boat). On the other hand, the islands are usually well equipped with electricity (through undersea cables, or local generators), and 3G (soon 4G) coverage is good.

Application Proposal: Rehab@Home with Kinect

Our proposal's main aim consists of remote physiotherapy monitoring system for rehabilitation. The software monitors exercise sessions for patients in rehabilitation after shoulder, hip or knee surgery. By using the Kinect sensor device and Kinect for Windows SDK (C#) we allow the patient to do the sessions at home giving feedback on the quality and frequency of the exercise to the physiotherapist expert remotely.

Project Members

This project is collaboration among Åbo Akademi university in Turku (Finland), Turku University of Applied Sciences (*Well-being Services,* directed by a Physiotherapy team) and the *Dept. of Computer Science and Artificial Intelligence, University of Granada, Spain.* Part of the collaboration is Virtu Project, formed by a group of regional colleges of higher education (http://www.virtuproject.fi/). The general aim in Virtu as well as our project is at the individual level to help elderly in the archipelago area to continue living at home, support their social interaction, improve their quality of life and increase their safety.

Application UI

The application uses Microsoft Kinect for Windows SDK (C#) although some tests were done also with OpenNI C++ (they use different skeleton representations).
The application allows recording new patterns from different users realizing exercises for the system to learn recognizing them:

- **Record** and **Replay**: Records a session for training the system. Audio option activates and ends recording via voice ("Record", "Stop")
- **Stabilities**: Indicates the degree of stability of the skeleton tracked.
- **Capture** and **Delete Gesture**: Adds (and deletes) a template gesture to a gesture-learning model.
- **Capture T**: adds a template posture to a posture learning model.
- **View Depth/View color**: Shows depth/color image
- **Exercises** to be trained & recognized:
  In FRONT position with the camera:
    - **Left and RightHipAbduction**
    - **Left and RightKneeExtension**

  In PROFILE position with the camera:
    - **Left and RightHipExtension**
    - **Sit and Stand**

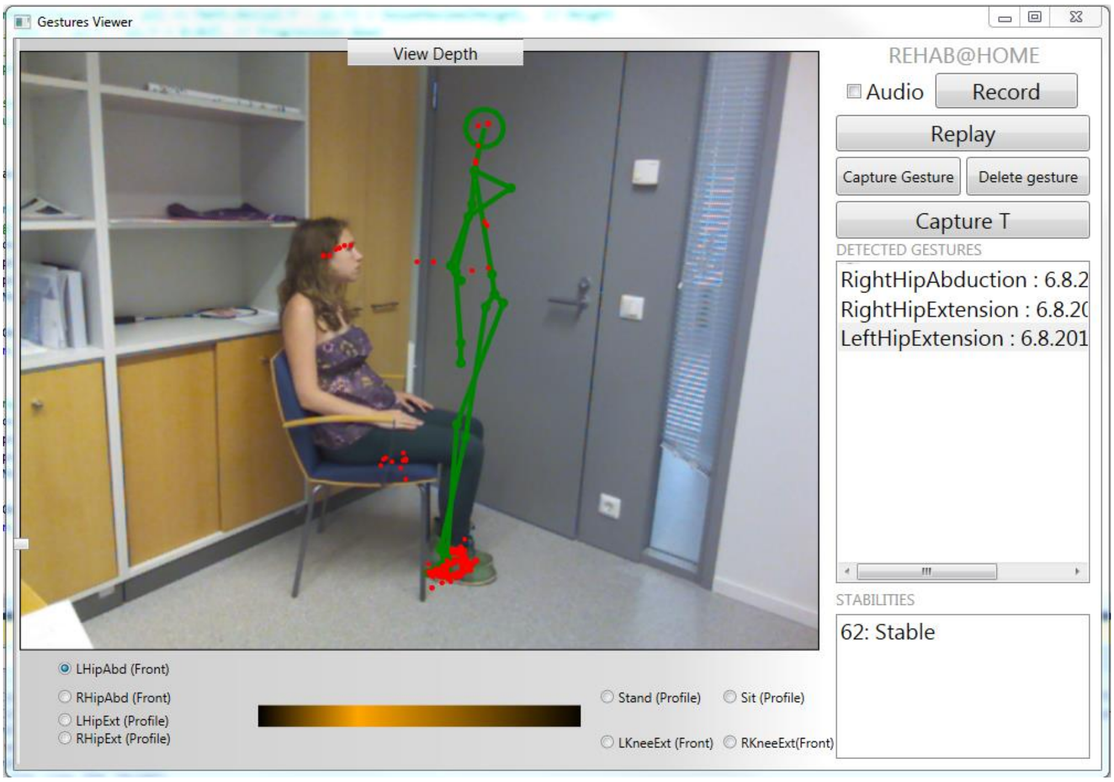
Use case: "Five times sit to stand test"
[http://web.missouri.edu/~proste/tool/5x-STS.rtf]
Metaanalysis results "demonstrated that individuals with times for 5 repetitions of this test exceeding the following can be considered to have worse than average performance" (Bohannon, 2006)

60-69 y/o 11.4 sec

70-79 y/o 12.6 sec

80-89 y/o 14.8 sec.

- To start session: touch your head ONCE until you hear the tin sound ONCE.
- To stop session: touch your head again ONCE until you hear the tin sound TWICE.



Future Work

- RESTful API of Smart-M3 through client that provides REST SPARQL request and returns a JSON response.

Sensor integration from Philips store to Smart-M3 to obtain context-aware long-term evolution/changes.

- Extension of exercises and precision together with Trento Virtual Social Gym.
- Fuzzy Rules to allow imprecision, vagueness and uncertainty in knowledge representation.
- Development of a *Gesture Definition Markup Language (GDML)* with durations, angles and other constraints for Physiotherapists to express, in normalized way, the exercises.

Files Appendix:

- The AHA platform ontology: https://www.dropbox.com/s/sjyorm6wubli9zk/AHA.owl
- The Security & Access-control ontology: https://www.dropbox.com/s/ozpeawwafuv48oi/SecurityOntology.owl
- Kinect Ontology: http://users.abo.fi/rowikstr/KinectOntology/

- Examples of SPARQL queries (can be executed on the WebSIBExplorer): https://www.dropbox.com/s/180oe6w2602saqf/SPARQLQueries.txt
- Smart-M3 platform with different language APIs (or Knowledge Processors (KPs)):
  http://sourceforge.net/projects/smart-m3/
- Smart-M3 Tutorial:
  http://tucs.fi/publications/view/?pub_id=tWickstrom_Frank13a
- Sample code to insert data into M3 from C# (Kinect application): https://www.dropbox.com/s/f8rmr949fpdshj0/ConnectingToSmart-M3SampleCode.cs

More information: ndiaz@abo.fi, stefan.gronroos@abo.fi, johan.lilius@abo.fi